

Scheme of work – Cambridge IGCSE[®] Physics (US) 0443

Unit 10: Atomic physics

Recommended prior knowledge

This unit is composed of two major sections: *radioactivity* and *atomic structure*. It is likely that students will be aware of the existence of radioactivity but beyond the general view that it is bad and dangerous they are unlikely to be well informed. Some will know that background radiation has been an omnipresent and unavoidable factor throughout history whilst others will believe that radioactivity is invariably man-made and a recently invented danger. Some of the course will involve the reteaching of aspects of the subject that are firmly fixed within the student's understanding but which are simply wrong. Many students firmly believe that after two-half-lives have passed, the radioactive sample has disappeared entirely whilst others will be certain that one may determine the half-life by placing a radioactive sample on a set of scales and waiting for the reading to halve.

Students might well have a much clearer view of the other part of this unit. Most will, in some way, have encountered the particle model of matter and will be aware of the distinction between elements and compounds. The distinction between atoms and molecules is much less likely to be understood and the importance of the structure of an atom in both chemistry and physics might not be clear.

Context

Although the particulate nature of atoms is fundamental to the study of physics, an understanding of the precise nature of those particles is not vital before other parts of the course are dealt with. When pressure or temperature are explained in terms of the particles within a substance, it doesn't immediately matter if those particles are molecules or atoms. It might be well to leave this unit until later in the course. The term *ionisation* does not appear elsewhere in the syllabus and will need explanation. Some students, however, might have met it anyway.

Outline

This unit contains ideas that are important in understanding the fundamental nature of matter and when studied it can make vague and hazy ideas much clearer to the student; it is also likely to help those who are also studying chemistry.

(Please note: **(S)** in **bold** denotes material in the Supplement (Extended syllabus) only)

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
5.1 (a)	Show awareness of the existence of background radioactivity Describe the detection of α -particles, β -particles and γ -rays. (β^+ are not included: β -particles will be	Use a Geiger tube to detect background radiation and α , β and γ radiations. Emphasise that these radiations are emitted from the nucleus.	This website has an interesting history of Marie Curie: www.aip.org/history/curie/contents.htm

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
	taken to refer to β^-)		
5.1 (b)	State that radioactive emissions occur randomly over space and time State, for radioactive emissions - their nature - their relative ionising effects - their relative penetrating abilities	Show the presence of background radiation using a detector and explain that it varies from location to location. Show that it varies randomly over time. Use a radiation detector with suitable absorbers to show penetrating abilities. Use a diffusion type cloud chamber to show particle tracks and lead to discussion of ionising effects. A spark counter could also be used.	Unit 10: Past Paper Question Extension 1, 2 and 3
5.1 (b) (S)	Describe their deflection in electric fields and magnetic fields Interpret their relative ionising effects	Emphasise the links between the properties (penetration, ionisation, deflection by magnetic or electric fields) and the nature (charge, relative size, particles/e-m radiation).	
5.1 (c)	State the meaning of radioactive decay, using equations (involving words or symbols) to represent changes in the composition of the nucleus when particles are emitted	Emphasise that a radioactive material decays nucleus by nucleus over time and not all at once.	IGCSE Physics Coursebook CD-ROM Activity Sheet 23.3
5.1 (d)	Use the term half-life in simple calculations which might involve information in tables or decay curves	Extend to work from data involving long half-lives. Use a radioactive decay simulation exercise and if possible an experiment with a Geiger counter and short half-life isotope to plot decay curves.	This website has a good presentation to explain the meaning of the term 'half-life': www.colorado.edu/physics/2000/index.pl On the left-hand side click on Table of Contents. Scroll down to the bottom of the page and click on 'Meaning of half-life'. There is also a useful half-life simulation – a graph is plotted as an isotope decays (a variety of isotopes can be chosen). Click on Half-life. Or: www.youtube.com/watch?v=fToMbj3Xz2c www.youtube.com/watch?v=PYn8vFmyGPM www.youtube.com/watch?v=Tp2M9tndGG0

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
			Unit 10: Past Paper Question Core 3
5.1 (e)	Describe how radioactive materials are handled, used and stored in a safe way	This should arise naturally from the teacher demonstrations where these are permitted, and is best integrated within the unit as a whole extending discussion to cover industrial and medical issues.	Unit 10: Past Paper Question Core 1
5.2 (a)	Describe the structure of an atom in terms of a nucleus and electrons	Extension students could discuss the limitations of the simple atomic model.	
5.2 (a) (S)	Describe how the scattering of α-particles by thin metal foils provides evidence for the nuclear atom	This important piece of understanding can be placed in its historical context and provide useful discussion on the nature of scientific research. Emphasise how the overwhelming majority of the mass of an atom is concentrated in an extremely minute fraction of the whole atom's volume and that the density of nuclear matter is consequently huge.	This website has interesting historical background covering Rutherford, Curie, Becquerel and Rontgen: www.accessexcellence.org/AE/AEC/CC/historical_background.html
5.2 (b)	Describe the composition of the nucleus in terms of protons and neutrons Use the term proton number, Z Use the term nucleon number A Use the term nuclide and use the nuclide notation A_ZX	Explain that the proton number determines the number of electrons in the neutral atom and that this determines the chemical properties of the atom. Hence the proton number determines the chemical properties and so all atoms with the same proton number have the same chemical properties and so are atoms of the same chemical element. Nuclear reactions and decay series could be discussed to provide a focus for this section.	IGCSE Physics Coursebook CD-ROM Activity Sheet 22.1 Unit 10: Past Paper Question Core 2
5.2 (c) (S)	Use the term isotope Give and explain examples of practical applications of isotopes	Use many examples, concentrating on those that students will know something about, e.g. medical treatment and diagnosis, smoke alarms etc. Also include a few industrial examples e.g. checking whether juice cartons are sufficiently full, checking for faulty welding joints in pipelines.	This website has useful information on medical imaging, radioactive dating and detection of radioactivity: www.library.thinkquest.org/3471/medical_imaging.html